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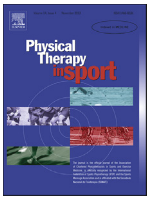

Original research

The effect of tackling on shoulder joint positioning sense in semi-professional rugby players

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ABSTRACT

Objective: To assess the effect of a tackling task replicating the force magnitudes and directions seen in a competitive game or training session, on a players shoulder joint position sense.
Design: Repeated measures design.
Setting: Field based.
Participants: Nineteen, senior, male, semi-professional rugby union players.
Main outcome measures: Two criterion angles of 45° and 20° off maximal range of shoulder external rotation in the 90° angle of abduction, were assessed for reproduction accuracy prior to, and following a field based tackling task against an opponent. A comparison between dominant and non-dominant side accuracy was also obtained.
Results: Prior to the tackling task, joint positioning sense was poorer at the 45° criterion angle than for 20° off the athletes' maximal range angle. Following the tackling task, error scores were significantly increased from baseline measures at the outer-range criterion angle for both dominant and non-dominant sides. In contrast to previous research the detrimental effect of the task was also greater. In addition, there was a significant decrease in accuracy at the 45° criterion angle for the players' non-dominant side.
Conclusions: This study found a significant decrease in accuracy of joint position sense following the tackling task. It also found this decrease to be greater than previous research findings. In contrast to previous studies that found no effect at the 45° criterion angle, this study found significant changes for the players' non-dominant side occurred at this angle. A possible explanation for this is that the sensory motor system is negatively affected by fatigue and consequently shoulder dynamic stability is reduced. This fatigue element explains the trend for increased injury frequency in the third quarter of the game and would provide a rationale for the inclusion of conditioning programmes that address fatigue resistance and motor co-ordination in the region.

1. Introduction

Rugby union is a vigorous contact sport, which due to the physical nature of the game exposes players to a high frequency of contact events, which leads to one of the highest risk for injuries of any sport (Bottini, Poggi, Luzuriga, & Secin, 2000). Although the lower limb is the most common site of injury (Brooks, Fuller, Kemp, & Reddin, 2005), injuries to the shoulder are particularly costly in terms of time lost (Brooks & Kemp, 2008; Headey, Brooks, & Kemp, 2007), with 35–60% of injuries resulting from the tackle (Fuller, Brooks, Cancea, Hall, & Kemp, 2007; McIntosh, Savage, McCrory, Frechede, & Wolfe, 2010; Quarrie & Hopkins, 2008). Although physical contact has been linked to the vast majority of injury mechanisms to the shoulder region, what has not been explained are the potential risk factors which may increase the susceptibility to shoulder injury during contact events.

Normal shoulder joint function is dependent upon both static and dynamic stabilising mechanisms (Janwantanakul, Magarey, Jones, & Dansie, 2001). A combination of bony, capsular, ligamentous and muscular systems, serve to provide stability to the shoulder region in varying degrees. The bony constraint system has minimal influence (Lee, Liau, Cheng, Tan, & Shih, 2003), whereas the capsuloligamentous system contributes to stability at extreme positions of movement. In mid ranges of motion, it is the muscular system that provides the principal support, muscles contributing to

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joint stabilisation through activation of protective contraction reflexes, and adjustment of muscle stiffness (Carpenter, Blasier, & Pellizzon, 1998).

Optimal muscle action is under the control of accurate feedback into the central nervous system from the proprioceptive system (Tripp, Boswell, & Gansneder, 2004). In relation to the active stabilisers (muscular) around the shoulder, the passive tension generated in the muscle fibres of the internal rotators during the outer ranges of external rotation, would result in enhanced activity of the muscle spindles and further input into the central nervous system. Tension in the tendinous part of the internal rotators would also be increased, although research suggests that this structure is influenced more by tension generated through muscle fibre contraction, than by a slow passive stretch (Moore, 1984; Stephens, Reinking, & Stuart, 1975). It appears that greater positional awareness occurs towards the outer ranges of external rotation, as a result of this increased neural input. Positional acuity in the mid ranges of external rotation may be less accurate, due to a reduced level of sensory input from the surrounding structures (Janwantanakul et al., 2001). Any deleterious effects to this system could be linked to a reduction in efficiency of the active stabilisers, leading to an increased risk of injury and/or decrease in performance (Carpenter et al., 1998; Herrington, Horsley, Whitaker, & Rolf, 2008).

Takarada (2003) and Suzuki et al. (2004) found biomechanical evidence of serious structural muscle damage following a competitive rugby match, due to tackling requiring the head, neck and shoulder area to experience significant forces. A co-ordinated muscular recruitment pattern must then serve to develop rapid deceleration forces to stabilise the region at the point of impact. Previous research by Herrington et al. (2008) has shown a reduced ability to determine joint position at the outer ranges of joint motion following a tackling task, with no significant change in repositioning errors at the mid ranges.

What this supports is changes in the sensory motor system having a negative effect on joint stability in the outer ranges and potentially leaving a joint vulnerable to injury due to a decrease in muscle co-contraction co-ordination (Pedersen, Lonn, Hellstrom, Djupsjobacka, & Johansson, 1999). Although the research (Carpenter et al., 1998; Herrington et al., 2008) suggests a decrease in joint position sense, it is its extent that is not clear, as the methods utilised in the studies are not likely to have exposed the players to the magnitudes of force encountered during a competitive game or training environment. One of the principal factors affecting tackle injuries in rugby union is momentum, with either the tackled or tackling player running or sprinting prior to the tackle taking place (Garraway, Lee, & Macleod, 1999). Pain, Tsui, and Cove (2008) reported a maximum impact force of 819 N when a tackle is executed from a crouched position, with Usman, McIntosh, and Frechede (2011) finding maximal forces of 1660 N in a laboratory setting, and 1997 N during field testing using a 45 kg tackle bag. The higher impact forces seen in the field setting may be a reflection on the type of surface and the purchase a player can obtain when wearing studded boots, in contrast to training shoes worn in a laboratory setting.

Despite the growing number of studies examining the epidemiology of injuries in rugby union, and the general acceptance that injuries to the shoulder region are primarily as a result of the tackle, information on the intrinsic risk factors is lacking and does not necessarily replicate the true force magnitudes and directions likely to be encountered during a game. The aims of this study therefore looked at the effect of tackling in a field based setting on shoulder joint position sense in rugby players at mid and outer ranges, comparing the effect on the dominant and non-dominant side.

2. Method

2.1. Participants

Nineteen semi-professional rugby union players, from a first team squad of 28, at a single level 5 club were recruited for the study. Players were included if they either reported no previous history of shoulder injury, or were passed medically fit to return to training and competition at least 2 months previously. Players were aged between 22 and 32 (mean 26.7 (±3.2 years)). Their mean height was 1.71 m (±0.13 m), and mean mass was 94 kg (±8.6 kg), with a mean BMI of 32.7 (±5.7). Players had an average playing experience of 13.3 years (±2.7 years). Data collection took place 48 h after the last training session or match to allow sufficient recovery, whilst not impeding team preparations. The study was given ethical approval by Salford University research ethics committee, and all participants gave informed consent to participate in the research.

2.2. Procedures

Prior to baseline measurements, players completed a 10 min warm-up consisting of active range of motion exercises of shoulder flexion to 90°, and potentiating drills of press-ups and passing drills that players would normally undertake pre match/training before any contact or unit specific drills. The player's dominant side was then determined by ascertaining which side the player would prefer to tackle with.

The olecranon and ulna styloid process were marked using 1 cm square adhesive tape. The joint angle was captured and measured by obtaining a digital photograph (Samsung Digimax A7 digital camera, 7 megapixel resolution) on two reference lines; one horizontal line parallel to the treatment bed the player is lying supine on, and one line connecting the points marked on the olecranon and ulna styloid process. Pre and post tackling measurements were taken replicating the method of Herrington et al. (2008). The active repositioning sequences were repeated until the player had three attempts at 45° and further repeated for an angle 20° short of the athlete's maximal range of external rotation in 90° abduction. The mean was calculated for the three attempts of each respective range. Similar research by Herrington et al. (2008) support this method, and have produced good test–retest reliability ($r = 0.92$). For this study the between session test–retest reliability was obtained by testing a group of six separate players. The error scores for both target angles (45° and 20° off maximum external rotation) were determined and then reassessed 30 min later. Intraclass correlation coefficient comparison of first and second measurements revealed a correlation of 0.81 ($p = 0.001$), with a mean difference between measurements of 1.7° (±0.8°) with a 95% confidence interval of 0–3.3°. All setting angles were measured by digital inclinometer (Saunders Group, Minnesota, USA), which has been shown to have a high degree of intra and inter-tester reliability ($r = 0.91$–0.97) (Venturni, Andre, Prates, & Giacomelli, 2006). To avoid visual clues, players were blindfolded during the testing procedure. The error score was then calculated by subtracting the baseline angle from the reproduction angle. The order of testing was block ordered (45° or 20° off max) for each subject, and the sequence reversed post tackling drill. Following the baseline measurements the players then undertook an opposed tackling session. The course was set up as in Fig. 1.

Attacker and defender went in opposite directions around marker 1 before turning towards each other in the 10 m channel. The defending player performed 10 tackles with their dominant side. Players were instructed to tackle around the legs and utilise the arms; as is common practice in a game, and consistent with